Factsheet 03/05

Strawberry

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Angular leaf spot and bacterial leaf blight – two new notifiable strawberry plant diseases

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Xanthomonas fragariae **is the latest notifiable disease to attack UK strawberry plants. It is likely to have come from the continent where another new pathogen,** ***Xanthomonas arboricola*** **pv** ***fragariae*****, has also been discovered.** ***Xanthomonas fragariae*** **can lead to significant fruit losses but little is yet known of the risk** ***Xanthomonas arboricola*** **pv** ***fragariae*** **poses to the UK strawberry crop. This factsheet summarises the latest information available and gives practical advice on preventing entry and spread of these diseases in the UK.**

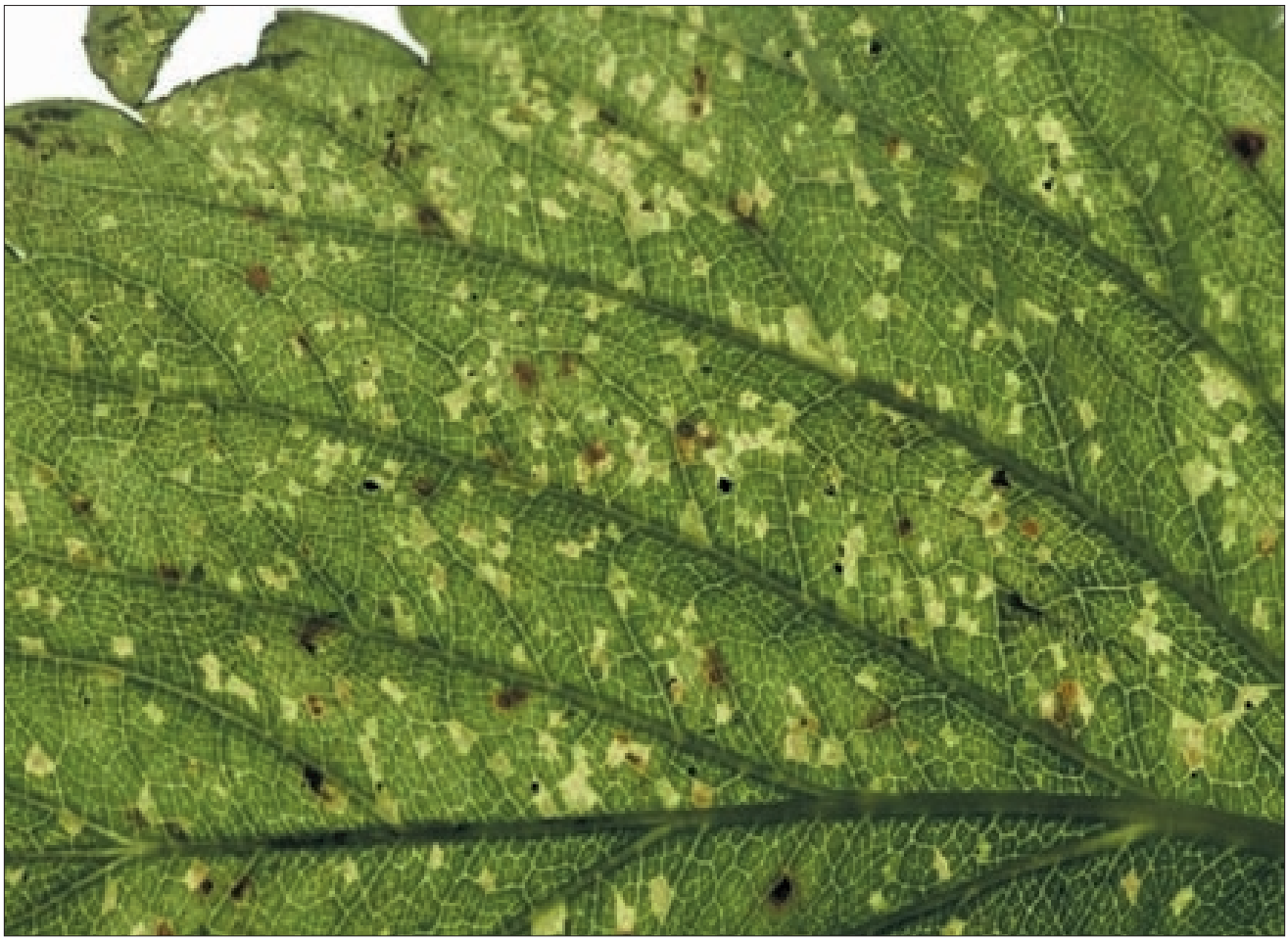

Fig 1 **Typical water-soaked angular leaf spot symptoms**

Background

Xanthomonas fragariae is the bacterium that causes angular leaf spot (Fig 1) on cultivated strawberry plants (*Fragaria* x *ananassa*). Originally discovered in the USA in 1962, it has eventually made its way to Europe, probably in planting material, and recent increased outbreaks in Belgium, Germany and the Netherlands have indicated that the pathogen was spreading. In December 2004 the first outbreaks of angular leaf spot disease were confirmed in Kent.

Angular leaf spot is an EU-listed

quarantine disease and all suspected outbreaks should be reported to the Defra Plant Health and Seeds Inspectorate (PHSI), which will advise on how to contain and eliminate the pathogen.

Another new bacterial pathogen, *Xanthomonas arboricola* pv *fragariae*, causes bacterial leaf blight in strawberry plants and was discovered in Italy in experimental and commercial fields in 1993-95.

Although more information is needed about the bacterium and how severely the leaf blight attacks strawberry plants, the European and Mediterranean Plant Protection Organisation (EPPO) has added it to their alert list, pending a further decision on whether to give it quarantine status.

Economic significance

Xanthomonas fragariae affects both June-bearer and everbearer varieties. Susceptibility differs greatly between varieties but resistance is not available in those grown commercially.

Experimental evidence suggests that wild strawberry species (*Fragaria virginiana* and *Fragaria vesca*) as well as some cinqufoil species (*Potentilla fruticosa* and *Potentilla glandulosa*) may be potential alternative hosts.

Like other strawberry leaf blights, *Xanthomonas fragariae* causes a reduction in fruit yield. Losses in Germany of 10-20% have been recently reported. Where fruit losses in southern Europe have been greater, the cases have usually been associated with the frequent use of overhead irrigation systems, which help the bacteria to spread and multiply on wet leaves. In the US, however, there have been reports of much heavier fruit losses, some as high as 75%.

The economic damage caused by *Xanthomonas arboricola* pv *fragaria* has yet to be fully determined. Although significant losses did not occur in Italy, there is evidence that some losses in southern Europe may have been mistakenly attributed to *Xanthomonas fragariae*, as both pathogens can occur simultaneously on strawberry plants.

Table 1 Symptoms of angular leaf spot

1. In the early stages of infection, angular (delineated by small veins in the leaf), shiny, water-soaked spots ranging in size from 1mm to 4mm can be seen on the underside of the leaf (Figs 2a-2b) and appear translucent when held up to the light (Fig 2c).

2. The spots coalesce more frequently along the larger veins, which sometimes show water-soaked dark streaks (Figs 3a-3b).

3. After about two weeks the spots enlarge and coalesce and can exude bacterial slime (Fig 4a). The spots have a shiny look and are usually covered by slime which when dry turns brown or silvery and appears as gum-like scales (Figs 4b-4c). Now visible on the top of the leaf, they become reddish-brown and necrotic (Fig 4d) and may be surrounded by a yellow zone.

4. Dead tissue tears away, giving the diseased leaf a ragged appearance resembling fungal leaf blight diseases such as leaf scorch (*Diplocarpon earliana*) and leaf blotch (*Gnomonia comari*).

5. In severe cases systemic infections of the crown may occur. This can only be seen when they are cut open, showing water-soaked zones, frequently confined to one side of the crown. Spots may also develop on the calyx, runners and crowns. Fruits and roots are not affected, although the fruit calyx may become dark and dry making the fruit unmarketable.

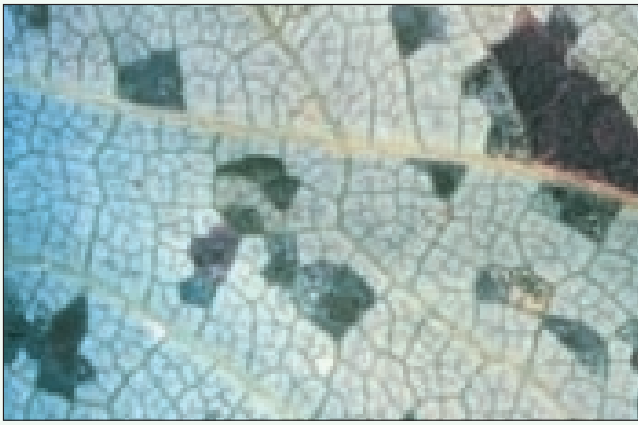

Fig 2a Angular spots, delineated by small veins in the leaf

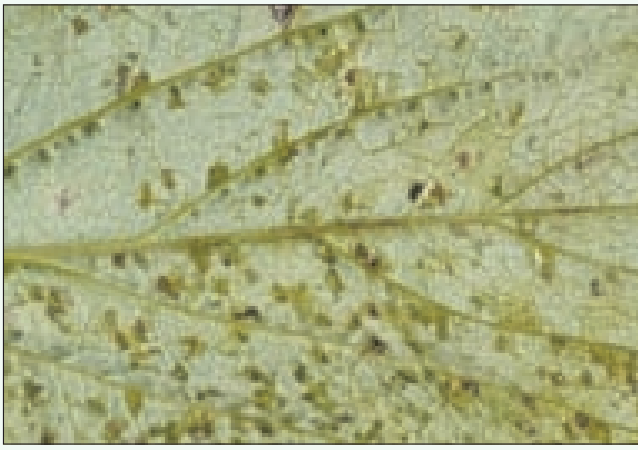

Fig 3a Angular leaf spots start to coalesce along the veins

Fig 4b The spots become shiny, covered by bacterial slime

Distribution

Xanthomonas fragariae was first found in the USA in 1962. In Europe, where it was first reported in Italy, including Sicily in 1973, and France in 1974, the disease has marched steadily onwards.

It later appeared in Greece in 1978 then in Portugal (1981), Romania (1985), Spain (1985), Switzerland (1993), Germany (1994), the Netherlands (1997), Belgium (1998) and has now appeared in the UK (2004).

In South America it has been reported in Argentina, Brazil, Chile (where it has been eradicated), Ecuador (where it is not established), Paraquay, Uruguay and Venezuela. Canada has also been affected.

It has also been found and eradicated in Australia and New Zealand as well as Africa (Ethiopia) and the French island of Réunion in the Indian Ocean.

Xanthomonas arboricola has so far been officially reported to occur only in Italy.

Fig 2b The spots are well defined with sharp edges

Fig 2c When held up to the light spots are translucent

Fig 3b Dark water-soaked streaks appear along the veins

Fig 4a Bacterial slime exudes from merging spots

Fig 4c Gum-like brown scales of dried slime cover spots

Fig 4d Larger spots turn reddish brown and necrotic

Symptoms

Weather and temperature conditions combine in the autumn to favour both diseases. However, optimal conditions for both diseases can also occur in cool, wet summer months.

Xanthomonas fragariae flourishes in cool, moist conditions with angular leaf spot symptoms usually appearing in late summer and early autumn with relatively cool days with a maximum temperature of 20ºC and cooler nights with high humidity (Table 1).

The symptoms of bacterial leaf blight, *Xanthomonas arboricola* pv *fragariae* are mainly seen in field-grown strawberries during autumn when air humidity is high (Table 2).

Infection and spread

The biology of *Xanthomonas arboricola* pv *fragariae* has yet to be studied but it is thought to be similar to that of *Xanthomonas fragariae* so it can be expected that the following can apply to both diseases.

What are the main sources of infection?

There are two main sources of infection for the bacteria:

- Old decaying leaf litter, from which infection spreads to young emerging leaves at the beginning of the growing season.

Table 2 Symptoms of bacterial leaf blight

Fig 5 Reddish brown lesions first appear

Fig 6 Lesions enlarge; no bacterial slime

Fig 7 V-shaped areas with chlorotic halo

Fig 8 Leaves are finally completely blighted

1. Small, reddish brown leaf lesions, which are neither water-soaked nor translucent, first appear on the underside of the leaf (Fig 5).

2. On the upper surface, these lesions eventually appear as reddish spots, but with no bacterial exudates. These enlarge with time (Fig 6) and are surrounded by a chlorotic halo.

3. In some cases, large brown V-shaped lesions, with a chlorotic surround, develop along the leaf margin (Fig 7). Lesions are also seen on the leaf midrib and petiole, which enlarge causing the tissue to blacken.

4. Finally the leaves turn yellow, wither and become completely blighted (Fig 8). Unlike symptoms of angular leaf spot, watersoaking is never observed.

- Crown infections in planting material.

How long can the bacteria survive?

- They cannot survive freely in soil, but can do so as a residue on infected leaves that remain on or in the soil. In this way they can survive from one crop to the next.
- They have survived for up to 2.5 years in dried infected leaves kept in the laboratory.
- They will survive cold storage in infected crowns.

How do the bacteria spread?

- They exude from primary lesions and spread by water splash from rain and sprinkler irrigation systems.
- They can spread through contact with workers' hands and on machinery, especially in humid conditions.
- Infected strawberry plants, that may remain symptomless, can spread the bacteria when planted.
- Plants, that may be systemically infected or contaminated with residues from infected leaves (often hidden in the apical crown or between the roots), can spread the bacteria when planted.

What is the infection pathway?

- Leaf penetration through the stomata.
- Crown infections occur through local wounds or systemically from affected leaves.
- Several cycles of infection can occur during a growing season.

What conditions favour the spread of infection?

- A combination of high humidity, moderate to cool temperatures (around 20°C) during the day and low temperatures at night more usually found in the autumn but can sometimes occur during a cool, wet summer.
- Systemic infections like damp nursery conditions, which encourages bacterial exudation and spread.

Control

There are no effective chemical treatments against these bacteria. Preventing the pathogens from entering and becoming established in commercial UK strawberry crops is the most appropriate and cost effective course of action (Table 3).

What should be done to prevent the diseases entering the UK?

- Obtain pathogen-free plants.
- Obtain planting material from reputable sources and ask for assurances that it is disease free.
- Consider using plants produced under an official certification scheme, which will have been produced under stringent conditions and inspected regularly.
- Have plants tested before dispatch as latent infections can occur without symptoms developing.
- Preferably, have plants tested while still in the cold store, before planting.
- Do not accept planting material without a valid plant passport.
- The EPPO recommends that strawberry planting material originating from countries where *Xanthomonas fragariae* is known to occur should be derived from mother plants that have been kept free from the pathogen as part of a certification scheme. It adds that the place of production should have been free from the disease for the past five growing seasons.
- Before planting, inspect all material for the characteristic angular spots on both old leaves and on their remains, which are still attached to the runners.
- Samples from lots kept in cold storage must be inspected immediately after the runners have thawed because after just one day at room temperature spots can no longer be seen.
- Ensure high standards of farm sanitation.
- Make sure visitors, workers and vehicles have not, wherever possible, visited other farms, and restrict their movement to necessary areas only.
- Wash hands and remove soil and debris from footwear when moving between strawberry crops. Consider using disinfectant pads and wearing disposable gloves, especially when dealing with higher grade propagation crops.
- Consider the movement of vehicles, machinery, visitors and staff so that they go first from areas of lowest risk, like higher-grade propagation crops, to areas of higher risk, such as lower-grade crops and especially fruiting crops. Fruiting crops should not be visited before going into propagation beds unless very strict hygiene measures have been undertaken.
- Limit the spread of debris and remove from the field if possible, after which it should be burned or deeply buried.
- Comply with the Defra code of practice regarding the disposal of agricultural and horticultural plant waste and soil on land.
- Clean machinery of debris and wash down with disinfectant between crops, especially after visiting fruiting crops.
- Inspect the crop regularly for any sign of disease.
- Inspect plants during the dormant season.
- Train staff to recognise the symptoms so that any disease can be identified early.

What should be done if disease is suspected?

- Immediately notify your local PHSI (or SEERAD inspector in Scotland).
- Further laboratory testing, arranged free of charge through the PHSI, will be required to verify the cause of symptoms.
- If the presence of either disease is confirmed the PHSI will provide advice on how to contain the pathogen and how put into place the necessary eradication procedure.

What additional control measures are advised in areas where angular leaf spot has occurred?

- Avoid overhead irrigation systems, which encourage multiplication and the spread of the pathogen.
- Allow at least two years between successive strawberry crops to reduce carrying over the bacteria from one crop to the next.
- Avoid working in wet fields and prevent workers and machinery moving from infected to non-infected fields.
- Products that contain copper have been moderately effective at controlling angular leaf spot in the US but have to be applied intensively with a risk of phytotoxicity. As yet there are no such products approved as foliar sprays for the control of these diseases in the UK.

Detection and control

New research at the Central Science Laboratory (CSL), funded jointly by Defra and the HDC, aims to develop a molecular detection service using the latest PCR technology. It is expected the new service will permit rapid and high throughput testing of strawberry planting material and so reduce the risk of infection entering the UK production system.

Detecting *Xanthomona fragariae* in infected plant material using existing methods is notoriously difficult. Isolating the pathogen from plant samples is unreliable because the growth of the bacterium is very slow and its colonies are easily overgrown by those of secondary organisms. Serological methods are available but are prone to false-positive reactions.

Existing PCR (polymerase chain reaction) methods have not performed well in recent evaluations conducted in official EU testing laboratories. The new test methods aim to address the shortfalls of existing ones and will also differentiate *Xanthomona fragariae* from the newly described *Xanthomona arboricola* pv *fragariae*.

Table 3 Checklist of tasks to help keep the UK disease free

Stages	Task
Preplanting	Buy in disease-free plants. Accept only material that comes with a valid plant passport and ensure that in countries where the disease has been found the mother stock plants are disease free. Carefully inspect all material on arrival for the angular spots. Check cold-stored runners immediately after they have been thawed.
Propagation beds	Restrict the movement of visitors, workers and vehicles. Make sure that fruiting crops have not been visited before going into propagation beds. Tighten hygiene procedures on the farm.
Fruiting crops	Check crops for signs of the disease. Train staff to recognise the symptoms. Clean all machinery of debris after visiting fruiting crops.
Post harvest	Remove all crop debris from the field and burn. Check plants during the dormant season.

Further information

In England and Wales your local Plant Health and Seeds Inspectorate (PHSI) office should be notified if an outbreak of either disease is suspected.

The PHSI can also be contacted for details of the UK Plant Health Propagation Scheme, the plant passport scheme and for further advice on avoiding either disease.

The PHSI headquarters are in York – tel: 01904 455174; fax: 01904 455197; email: planthealth.info@defra.gsi.gov.uk.

In Scotland SEERAD Plant Health Inspectors should be contacted on suspicion of a finding of either disease. SEERAD Head Office, Pentland House, 47 Robbs Loan, Edinburgh, EH14 1TY. Tel: 0131 556 8400; fax: 0131 244 6509/6539

More information is also available from these EPPO and Defra web pages:

- www.eppo.org/QUARANTINE/Alert_List/bacteria/xanafr.htm
- www.eppo.org/QUARANTINE/bacteria/Xanthomonas_fragariae/XANTFR_ds.pdf
- www.defra.gov.uk/planth/pestpics/qic34.pdf
- www.defra.gov.uk/planth/newsitems/angular.htm
- www.defra.gov.uk/planth/publicat/waste/index.htm
- www.defra.gov.uk/planth/publicat/passport/pass.pdf

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Additional notes

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